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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/658,711	09/08/2003	Avetik Harutyunyan	23085-08273	6981

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HONDA/FENWICK
SILICON VALLEY CENTER
801 CALIFORNIA STREET
MOUNTAIN VIEW, CA 94041

EXAMINER	
BURKHART, ELIZABETH A	

ART UNIT	PAPER NUMBER
1715	

NOTIFICATION DATE	DELIVERY MODE
06/22/2011	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

ptoc@fenwick.com

Office Action Summary	Application No.	Applicant(s)	
	10/658,711	HARUTYUNYAN, AVETIK	
	Examiner	Art Unit	
	ELIZABETH BURKHART	1715	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *30 March 2011*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-3,5-17,19 and 43-45* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-3,5-17,19 and 43-45* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date *3/31/11*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 3/30/2011 has been entered.

Claim Rejections - 35 USC § 112

The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

2. Claims 1 and 19 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. Regarding Claim 1, it is unclear if the entire thickness range can be used to produce single wall carbon nanotubes since [0057] of the instant specification discloses that values within the range do not produce single wall nanotubes.

Claim 19 recites the limitation "said carbon nanostructures" in line 1. There is insufficient antecedent basis for this limitation in the claim.

The following is a quotation of the fourth paragraph of 35 U.S.C. 112:

Subject to the [fifth paragraph of 35 U.S.C. 112], a claim in dependent form shall contain a reference to a claim previously set forth and then specify a further limitation of the subject matter claimed. A claim in dependent form shall be construed to incorporate by reference all the limitations of the claim to which it refers.

3. Claim 19 is rejected under 35 U.S.C. 112, 4th paragraph, as being of improper dependent form for failing to further limit the subject matter of the claim upon which it depends, or for failing to include all the limitations of the claim upon which it depends. Claim 19 recites the limitation “one-dimensional carbon nanostructures” which does not further limit claim 1 since the term is interchangeable with single-walled carbon nanotube as defined by the instant specification [0022]. Applicant may cancel the claim(s), amend the claim(s) to place the claim(s) in proper dependent form, rewrite the claim(s) in independent form, or present a sufficient showing that the dependent claim(s) complies with the statutory requirements.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

4. Claims 1, 3, 5-15, 17, 19, and 43-45 are rejected under 35 U.S.C. 103(a) as being unpatentable over Dai et al. (US patent number 6232706) in view of Muroyama et al. (US Patent publication 2002/0036452) and Sun et al (US 2002/0160111) and further in view of Xu et al (US 5,872,422).

With regard to claims 1 and 11, Dai et al. includes a method for synthesizing carbon nanostructures including providing a substrate having a deposition mask (column 3 lines 57-59), depositing an Fe layer on a on an unmasked portion of the substrate, removing the mask (shadowmask 48 in Figure 3) oxidizing the Fe layer to form a growth catalyst then exposing the substrate to a carbon precursor gas at a deposition temperature to form carbon nanostructures (columns 3 and 4 lines 44-10). Dai also teaches that the oxidizing agent is air in columns 3-4 lines 45-10. Dai et al. does not include using an organometallic Fe layer instead of only Fe. Muroyama et al. discloses using a metalorganic layer (paragraph 0050 and examples 11 and 12) that may include a Fe metalorganic layer (paragraph 0098) as a catalyst layer for depositing carbon nanostructures deposited by PVD or CVD (paragraph 0097) to improve the carbon nanofilm/nanostructures grown in the property of selective growth (paragraph 0050). It follows that the organic portion of these precursors will be volatized as the final catalyst layer is a metal/metal oxide.

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify Dai et al. to include metalorganic Fe instead of just Fe as taught by Muroyama et al. in order to improve the carbon nanofilm/nanostructures grown in the property of selective growth.

Dai et al. and Muroyama et al. do not teach that the catalyst may be bimetallic or trimetallic. Sun discloses depositing carbon nanotubes for field emission devices (Abstract) wherein the metal catalyst layer may be bimetallic in order to tune the density of carbon nanotubes [0030]. Further, the thickness of the metal catalyst layer is less

than 100 microns (Claim 4) and the deposition conditions may be controlled to deposit single wall carbon nanotubes [0033].

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify Dai et al. and Muroyama et al. to include using bimetallic or trimetallic catalysts as taught by Sun in order to tune the density of the carbon nanotubes.

With regard to the thickness limitation of claims 1 and 43-45, the thicknesses of the layers in Muroyama et al. depend upon the desired device characteristics. One of ordinary skill in the art would recognize that an electron emission device would have layers with thicknesses in the micron range. Xu discloses electron emission devices (Abstract) wherein carbon nanostructures are catalytically formed by depositing a metal catalyst film (e.g. Fe, Co, Ni, etc.) having a thickness of less than 100 microns. The thickness of the catalyst film may be adjusted to deposit a carbon nanostructure having desired characteristics and density (Col. 7, lines 35-65). The catalyst film may a metal compound which is pyrolyzed to form the metal growth catalyst (Col. 20, lines 4-6). It would have been obvious to one of ordinary skill in the art at the time of invention by applicant to adjust the thickness of the metalorganic layer of Muroyama to within the claimed range as suggested by Xu in order to obtain desired nanostructure characteristics, such as density.

With regard to claim 3, Dai et al. discloses using a physical vapor deposition process to deposit iron (column 5 lines 44-47), which would deposit the metalorganic when combined with Muroyama et al.

Regarding claims 5-6, Muroyama et al. discloses the mask to be aluminum oxide in paragraphs 0096 and 0099.

Regarding claims 7 and 8 the substrate is composed of silicon oxide in Dai et al. column 3 lines 60-65.

Regarding claims 9 and 10 Dai et al. discloses the substrate annealed in an oxidizing atmosphere at 300 °C overnight (column 3 lines 59-60). One of ordinary skill in the art would recognize that if a shorter time was desired, the temperature should be increased, or if the temperature were decreased the annealing would take longer. Therefore these values are by routine experimentation and are not inventive. It would have been obvious to one of ordinary skill in the art at the time of the invention to modify Dai et al. to include annealing the iron in an oxidizing atmosphere from 2-4 hrs at 450-500 °C depending on the time and temperature requirements of the system absent evidence showing a criticality for the claimed values. Further, the organic portion of the layer must be vaporized as when the layer is used as a catalyst, only a metal/metal oxide remains as the layer. It is also noted that the temperature will also depend upon the volatility of the organic component.

With regard to claims 12-14, Dai et al. discloses the exposure to carbon precursor gases 15-60 minutes in column 4 lines 2-4 and Muroyama et al. discloses using methane, hydrogen and argon to deposit carbon nanotubes to stabilize the gases and possible plasma discharge and deposit carbon nanotubes (paragraph 0103).

Regarding claim 15, Dai et al. discloses the deposition temperature of ethylene as a precursor gas at 700 °C (column 4 lines 1-3).

Regarding claim 17, Dai et al. uses the mask to pattern the substrate as shown in Figure 3, shadowmask 48. The mask is present during step B, the deposition of the organometallic material, and is not present during step C when the carbon is deposited. One of ordinary skill in the art would realize that removing the mask before or after the oxidation of the organometallic material would not make a difference in the procedure or Dai et al. as long as it was removed before the deposition of the carbon. Therefore, it would have been obvious to one of ordinary skill in the art to remove the mask before or after oxidation of the organometallic material in order to allow the carbon to be deposited.

Regarding claim 19, Dai et al. shows single walled 1D carbon nanotubes in Figure 3, reference number 28 and describes the nanotubes in columns 1 and 2 et seq.

5. Claim 2 is rejected under 35 U.S.C. 103(a) as being unpatentable over Dai et al. in view of Muroyama et al., Sun et al., and Xu et al. as applied above, and further in view of US patent number 5863601 to Kikuchi et al.

Dai et al., Muroyama et al., Sun et al., and Xu et al. include the limitations of claim 2 as discussed above except for using iron phthalocyanine as the metalorganic layer. Kikuchi et al. teaches using metalorganic material to be composed of Fe and phthalocyanine when forming carbon nanotubes in order to use a compound that will be useful in both CVD and PVD (column 2 lines 60-66).

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify Dai et al., Muroyama et al., Sun et al., and Xu et al. to include iron

phthalocyanine as the metalorganic layer as taught by Kikuchi et al. in order to use a compound that will be useful in both CVD and PVD.

6. Claim 16 is rejected under 35 U.S.C. 103(a) as being unpatentable over Dai et al. in view of Muroyama et al., Sun et al., and Xu et al. as applied above, and further in view of US Patent 4650895 to Kadokura et al.

Dai et al., Muroyama et al., Sun et al., and Xu et al. include the provisions of claim 16 except purifying the organometallic compound before use. Kadokura et al. teaches purifying an organometallic compound before use with a procedure that could be used with the method of Dai et al., Muroyama et al. and Smalley et al. in order to remove impurities from the organometallic compound and prevent unwanted reaction products (column 1 lines 1-45).

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify Dai et al., Muroyama et al., Sun et al., and Xu et al. to include purifying the organometallic substance before use as taught by Kadokura et al. in order to remove impurities from the organometallic compound and prevent unwanted reaction products.

Response to Arguments

7. Applicant's arguments, directed to the new limitation of claim 1 that single walled nanotubes are formed using a catalyst layer having a thickness of 1-30 microns, have been addressed in the rejection above. Specifically, Xu discloses using a catalyst layer having a thickness of less than 100 microns wherein single-wall or multi-wall nanotubes

may be formed (Col. 9, line 32) and Sun discloses that single wall nanotubes may be formed by controlling the deposition conditions [0033].

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to ELIZABETH BURKHART whose telephone number is (571)272-6647. The examiner can normally be reached on M-Th 7-5:30.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Timothy Meeks can be reached on 571-272-1423. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Elizabeth Burkhart/
Examiner, Art Unit 1715